Volume 4, Issue 3, March 2014 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Analysis of Fingerprint Compression using SPIHT Technique for Significant Threshold Level

Mridula Purohit*
Department of Mathematics, Vivekananda Institute of Technology (East), India

Nitesh Kumar
Electronics and Communication, Vivekananda Institute of Technology (East) India

Abstract— Fingerprint analysis plays crucial role in legal matters such as authentication of person, investigation of crime and many other significant applications where fingerprint image contain huge amount of data. Hence to get the significant information from the finger print, there is need of reducing the data. To achieve this task there is need to compress image, and a commanding tool for image compression to compress fingerprints. Presently there is a wide range of compression technique but for our purpose there is need to develop faster, and efficient and reliable techniques to compress fingerprint images. Wavelet based image compression technique is widely accepted and most popular technique. To achieve accepted level of compression, there is need to compress the fingerprint images at a significant threshold value. In this paper to achieve high compression ratio, wavelet based SPIHT algorithm is used for compression of fingerprint image to get significant range of threshold level. In the experiment Haar wavelet is applied and analysis is done on the basis of compression ratio and SSIM values. To achieve best compression ratio and without degrading the quality of image to an unaccepted level, experiment is performed on MATLAB platform.

Keywords— Wavelets, Wavelet Packets, SPIHT, SSIM, Threshold level, Compression ratio.

I. INTRODUCTION

Basically image contains large amount of information that requires much storage space and large transmission time. Therefore it is often necessary to compress the image by storing the necessary data to reconstruct the image. Hence to reduce the cost of storage and increase the transmission speed at available bandwidth, compression is required. Image compression involves reducing the amount of data (bits) required to represent a digital image [1] [2] [3].

Image compression is a process to reduce the size in bytes of a graphics file without mortifying the quality of the original image and compression is done upto an acceptable level. This process of minimizing the file size results in greater space and resulting the storage of large number of images in a given disc or storage. This process also results in reducing time for sending images on the Internet or downloaded from Web pages. In the image compression only region of interest is recovered and compression is done such a way so that redundant information and repeated pixels are removed from the signal source (image/video). Various methods have been used for still image compression. Image compression always follows few fundamental steps and they are: transformation, quantization and encoding as shown in Fig.1.

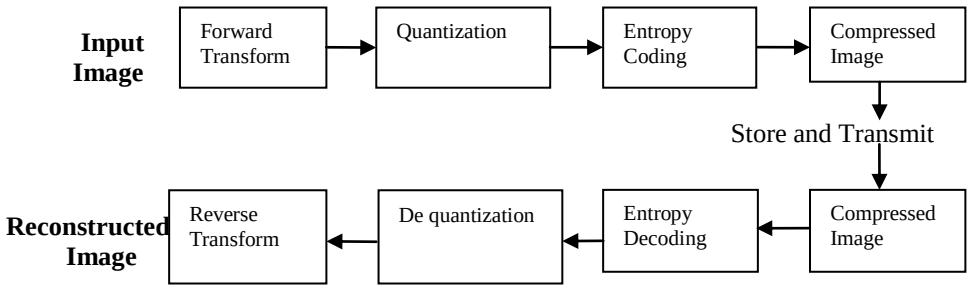

Fig.1 .Flow diagram of Image Compression using DWT

Compression plays very significant role in fingerprint also. Fingerprint is used for many application like medical, legal matters, investigation of crime etc. like medical images, fingerprint, internet data There are many image compression techniques available exists like DCT, JPEG, and JPEG2000 [4][5] and Wavelet etc. all these techniques have their common aim to achieve high compression ratio. Among the exiting compression techniques Wavelet gives better results for lossless as well as lossy image compression.

II. WAVELETS

Wavelet is a mathematical function which divides the data into different frequency components, then fits each component with a resolution suitable for its scale [18]. Wavelets are functions generated from a single function by dilations and translations[19].

Wavelet based image compression is based on Discrete Wavelet Transform (DWT)[12]. For wavelet based image compression many coders [7][8][9][10] [11][12] are used. There were some wavelet based algorithms which were used in earlier [13][14]. The wavelet based image compression technique based on set partitioning in hierarchical trees (SPIHT) [9] [10]. This is a powerful, efficient simple image compression algorithm and results in a far better method in terms of performance when compared to the Embedded Zerotree wavelet algorithm [7].

III. SET PARTITIONING IN HIERARCHICAL TREES

Fingerprint images can be relates or understand in the formation of texture patterns of flow orientations and here flow orientations have sharp discontinuities. For the compression of this particular property of fingerprint images and to preserve or maintain the crucial details of the edges and their connections, the wavelet decomposition method is most significant [15][16]. Many algorithms have been implemented but SPIHT algorithm is most efficient algorithm to other ones. Many algorithms are based on wavelet based image compression. SPIHT is also a wavelet based algorithm and vary popular technique for image compression. Said and Pearlman [10] introduced the set partitioning in hierarchical trees (SPIHT) algorithm. SPIHT technique is a very simple and efficient technique which results in better SSIM and PSNR value for given compression ratios. Optimal progressive transmission and compression are two parameters for which SPIHT is designed.

Reconstructed image is targeted to set at zero by progressive transmission method and priority of progressive transmission is to transfer region of interest part (ROI) first. The transformed image is sent to the SPIHT encoder in such a sequence that will make the decoder to decode the most important details (ROIs) first and followed by the less important details. Most significant bits of significant coefficients that contain the significant information for reconstructing the image are sent first by the process. The SPIHT technique is one of the most superior methods available that surpasses even the modern JPEG 2000 under certain circumstances

IV. WAVELET PROPERTIES

To attain a high compression rate, there is necessity to select best filter bank, decomposition level and threshold value. These all factors play a significant role during compression of the image or fingerprint images. All the filters show different property with different types of images because of unavailability of filter which give best result for all types of images[17]. The Current Compression system uses biorthogonal wavelet filters instead of orthogonal. Because orthogonal filters have a property of energy preservation whereas biorthogonal filters lack it [9],[10]. So there is need of optimal filter and selection of optimal filter depends upon selection of threshold, quality of image and many other surrounding atmospheric components. Here Haar wavelet is used for the experiment.

V. EXPERIMENTS

The six different fingerprint images of two persons (Group 1 and Group 2) are taken from a database where the images are taken at different light conditions. Thus, these fingerprint images contains noisy images. These images of Group1 and Group 2 are compressed using SPIHT technique and the Haar wavelet is used in the technique. The experiment is performed on Core i3 HP laptop with 4 GB Ram. The software MATLAB 7.10(R2010a) is used for the experiment.

In the experiment , the fingerprints of Group 1 and Group 2 are compressed using SPIHT technique at different threshold levels. The compression ratio obtained for Finger 1 to 6 of Group 1 and Group 2 at threshold level 5, 7, 9 , 11, 13 and 15 are given in TABLE I and TABLE 2 respectively.

TABLE I
COMPRESSION RATION OF DIFFERENT FINGERS AT DIFFERENT CONDITIONS FOR GROUP ONE

Threshold Value	COMPRESSION RATIO (IN %)					
	Finger 1	Finger 2	Finger 3	Finger 4	Finger 5	Finger 6
Th. 5	55.67	54.72	55.47	61.89	63.07	58.29
Th. 7	65.29	64.97	65.74	70.96	71.13	67.45
Th. 9	71.47	71.66	71.67	75.81	76.64	73.5
Th. 11	76.27	76.61	76.26	81.11	80.59	78.07
Th.13	76.67	80.08	79.67	86.24	83.52	81.36
Th.15	79.93	83.03	82.13	90.93	85.78	83.95

TABLE II
COMPRESSION RATION OF DIFFERENT FINGERS AT DIFFERENT CONDITIONS FOR GROUP TWO

Threshold Value	COMPRESSION RATIO (IN %)					
	Finger 1	**Finger 2**	**Finger 3**	**Finger 4**	**Finger 5**	**Finger 6**
Th. 5	80.48	76.48	77.82	68.33	66.71	67.99
Th. 7	86.21	85.67	84.47	78.03	75.26	77.14
Th. 9	89.16	88.89	87.78	83.02	80.83	82.57
Th. 11	90.71	89.99	89.72	86.18	85.29	85.95
Th.13	91.98	91.07	90.88	88.22	87.64	88.21
Th.15	92.3	92.75	91.69	89.6	89.21	90.00

The structural similarity (SSIM) index is a method for measuring the similarity between two images. The TABLE III and TABLE IV shows the structural similarity (SSIM) index of fingerprint images from Group 1 and Group 2 compressed at different threshold level as compared to the original image.

TABLE III
SSIM OF DIFFERENT FINGERS AT DIFFERENT CONDITIONS FOR GROUP ONE

Threshold Value	STRUCTURAL SIMILARITY (SSIM) INDEX					
	Finger 1	**Finger 2**	**Finger 3**	**Finger 4**	**Finger 5**	**Finger 6**
Th. 5	0.98	0.98	0.98	0.98	0.98	0.98
Th. 7	0.97	0.97	0.97	0.97	0.98	0.97
Th. 9	0.96	0.96	0.96	0.96	0.97	0.96
Th. 11	0.94	0.95	0.95	0.95	0.96	0.95
Th.13	0.93	0.93	0.94	0.93	0.94	0.94
Th.15	0.92	0.92	0.92	0.92	0.93	0.92

TABLE IV
SSIM OF DIFFERENT FINGERS AT DIFFERENT CONDITIONS FOR GROUP TWO

Threshold Value	STRUCTURAL SIMILARITY (SSIM) INDEX					
	Finger 1	**Finger 2**	**Finger 3**	**Finger 4**	**Finger 5**	**Finger 6**
Th. 5	0.97	0.98	0.97	0.97	0.97	0.97
Th.7	0.96	0.97	0.96	0.96	0.96	0.96
Th. 9	0.95	0.96	0.94	0.95	0.95	0.94
Th.11	0.93	0.94	0.93	0.93	0.93	0.93
Th.13	0.92	0.92	0.93	0.92	0.92	0.91
Th. 15	0.91	0.91	0.92	0.91	0.91	0.90

From the TABLE I and TABLE II and its objective evaluation (Fig.2), it can be stated that as we increase the threshold value , compression is also increased in terms of compression ratio and this phenomena occurs till threshold value 9 and after threshold value 11 for almost all fingerprint images of Group 1 as well as Group 2 there is negligible changes in compression ratio . This can easily be viewed in line chart of Compression ratios Vs Fingerprint images at different threshold level (Fig.3).

From the TABLE III and TABLE IV and its objective evaluation (Fig.4), it can be stated that as threshold level of compression increases, the structural similarity (SSIM) index of compressed image decrease and the significant range of SSIM is between 9 to 11.

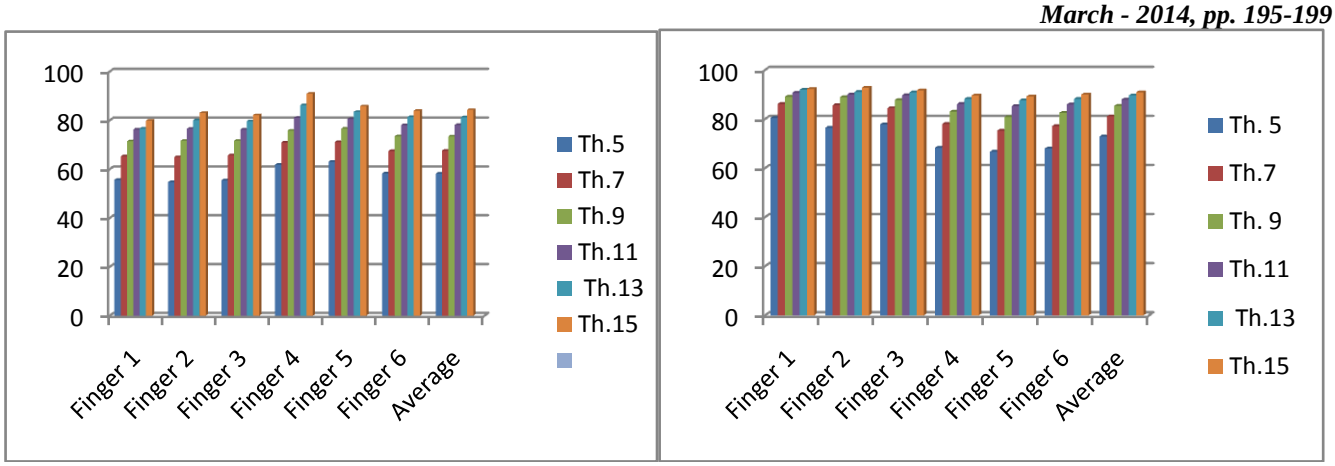

Fig.2 Objective Evaluation, Compression Ratio vs. Threshold Value (a) Type 1 (b) Type 2

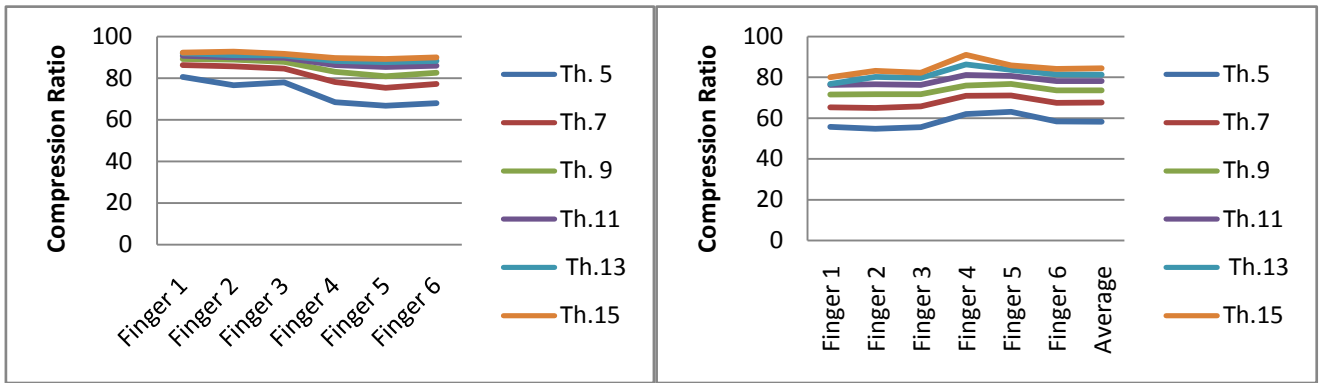

Fig. 3 Objective Evaluation, (a) Compression Ratio vs. Fingerprint at different Threshold Value for Group 1 (b) Compression Ratio vs. Fingerprint at different Threshold Value for Group 2

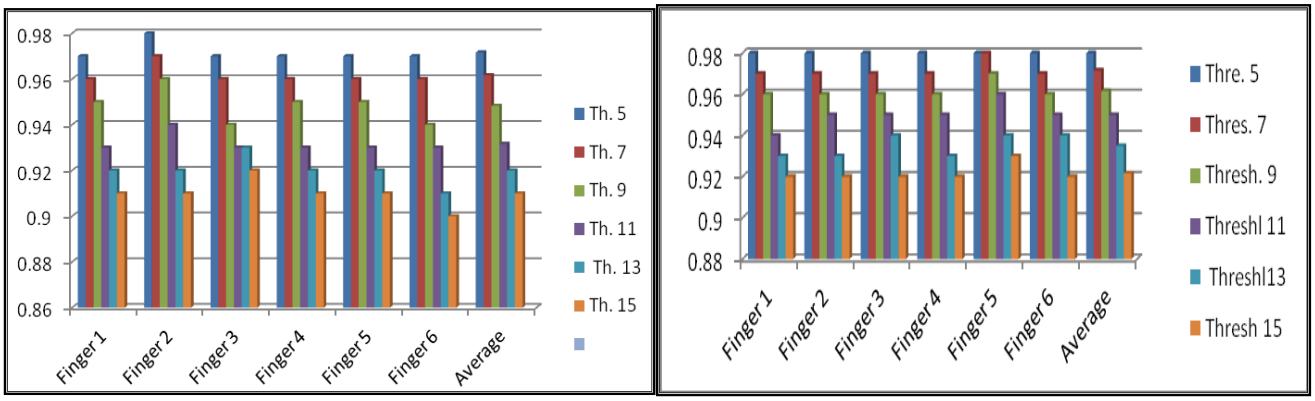

Fig. 4 Objective Evaluation, (a) SSIM vs. Fingerprint at different Threshold Value for Group 1 (b) SSIM vs. Fingerprint at different Threshold Value for Group 2.

VI. CONCLUSIONS

In the present paper, different fingerprint impression of two persons (Group 1 and Group 2) are taken and compressed at different threshold levels 5,7,9,11,13 and 15. The compression ratio (CR) and the structural similarity (SSIM) index were computed and compared of all compressed images and for objective evaluation, column graphs and line graphs are drawn. The compression ratio (CR) is directly proportional to the threshold value of the compression and the structural similarity (SSIM) index is inversely proportional to threshold value of the compression. The significant range of compression is optimum compression ratio without degrading the quality of the image to an unacceptable level. The optimum range of threshold is 9-11 as compression ratio become stagnant after 9-11 threshold level. The threshold range 9-11 is also optimal for SSIM as quality of compressed image degrades rapidly after 9-11 range.

ACKNOWLEDGMENT

This work is supported by All India Council of Technical Education (AICTE) under grant 8023/RID/RPS-163(Pvt.)/2011-12.

REFERENCES

[1] K. Sayood, "Introduction to data compression" Second Edition, Morgan Kaufman publisher, 2002.

[2] R. B. Polikar , "Wavelet Tutorial Part I, II, III, and IV", 2003, http://users.rowan.edu .
[3] David Salomon, "Data Compression the Complete Reference", 2nd Ed. Springer , 2002.
[4] M. Sonka and R. Boyle, "Image Processing Analysis & Machine Vision" , Reprint By International Thomson Computer Press, 1996 .
[5] R.R.Coifman, Y. Meyer and M.V. Wickerhauser, "Wavelet Analysis and Signal Processing" , Wavelets and their applications, ed. Ruskai et al (1992) pp. 153-178, Jones & Bartlett, Boston.
[6] D. S. Taubman, Author; M. Rabbani, Reviewer; M. W. Marcellin, Editor , "JPEG2000: Image Compression Fundamentals, Standards and Practice" , J. Electron. Imaging , 11(2), 286-287 , Apr 01, 2002 .
[7] R. L. Joshi, V. J. Crump and T. R. Fisher, "Image subband coding using arithmetic coded trellis coded quantization," IEEE Trans. Circuit Syst. Video Technol., vol. 5, pp. 515–523, Dec. 1995.
[8] R. L. Joshi, T. R. Fisher and R. H. Bamberger, "Optimal classification in subband coding of images," in Proc. 1994 IEEE Int. Conf. Image Processing, vol. II, Austin, TX, 1994, pp. 883–887.
[9] J. Shapiro, "Embedded image coding using zero trees of wavelet coef-ficients," IEEE Trans. Signal Processing, vol. 41, pp. 3445–3462, Dec.1993.
[10] A. Said and W. A. Pearlman, "A new fast and efficient image codec based on set partitioning in hierarchical trees," IEEE Trans. Circuits Syst. Video Technol., vol. 6, pp. 243–250, June 1996.
[11] C. Herley, Z. Xiong, K. Ramchandran and M. Orchard, "An efficient algorithm to find a jointly optimal time-frequency segmentation using time-varying filter banks," in Proc. Int. Conf. Acoust., Speech, Signal Processing, Detroit, MI, vol. II, 1995, pp. 1516–1519.
[12] P. Sriram and M. W. Marcellin, "Wavelet coding of images using trellis coded quantization" in SPIE Conf. Visual Inform. Process., Orlando, FL, Apr. 1992. Pp. 238-247; also "Image coding using wavelet transforms and entropy-constrained trellis quantization, ' IEEE Trans. Image Processing, vol. 4. Pp. 725-733, June 1995.
[13] G.M. Davis and A. Nosratinia. "Wavelet-based Image Coding: An Overview. Applied and Computational Control", Signals and Circuits Vol. 1, No. 1, 1998.
[14] S.G. Mallat, A Wavelet Tour of Signal Processing, Academic Press, 1999.
[15] Karen Lees, "*Image Compression Using Wavelets*", Report of MS, 2002.
[16] P.D.Deshmuk, R.R. Manza and K.V.Kale "*Decomposition for Fingerprint images*"Proceeding National Conference CCS-04 Aurangabad Conducted by IETE Chapter and Dept. of Comp. Science Dr. BAMU Aurangabad, India 2004.
[17] S. Saha & R. Vemuri "Analysis based adaptive Wavelet filter selection in Lossy image coding schemes", ISCAS-2000- IEEE International Symposium on Circuits and systems May-28-31,2000, Genewa, Switzerland.
[18] R. M. Rao and A. S. Bopadikar, "Wavelet Transforms: Introduction to Theory and Applications", Pearson Education, Asia, 2002.
[19] E.J. Stollnitz, T.D. DeRose and D.H. dan Salesin, "Wavelets For Computer Graphics: Theory and Applications", Morgan Kaufman Publisher, USA, San Fransisco, 1996.

